DRAWDOWN GA

Identifying the most promising solutions for reducing carbon emissions in Georgia

Overview of the Drawdown Georgia Sessions at The Southface Institute's Greenprints Conference
August 6, 2020

Georgia Tech | University of Georgia | Emory University | the Ray C. Anderson foundation

Welcome

Daniel Rochberg
Emory University

DRAWDOWN GA

Georgia Drawdown Updates

Dr. Marilyn Brown, Regents Professor
Georgia Institute of Technology

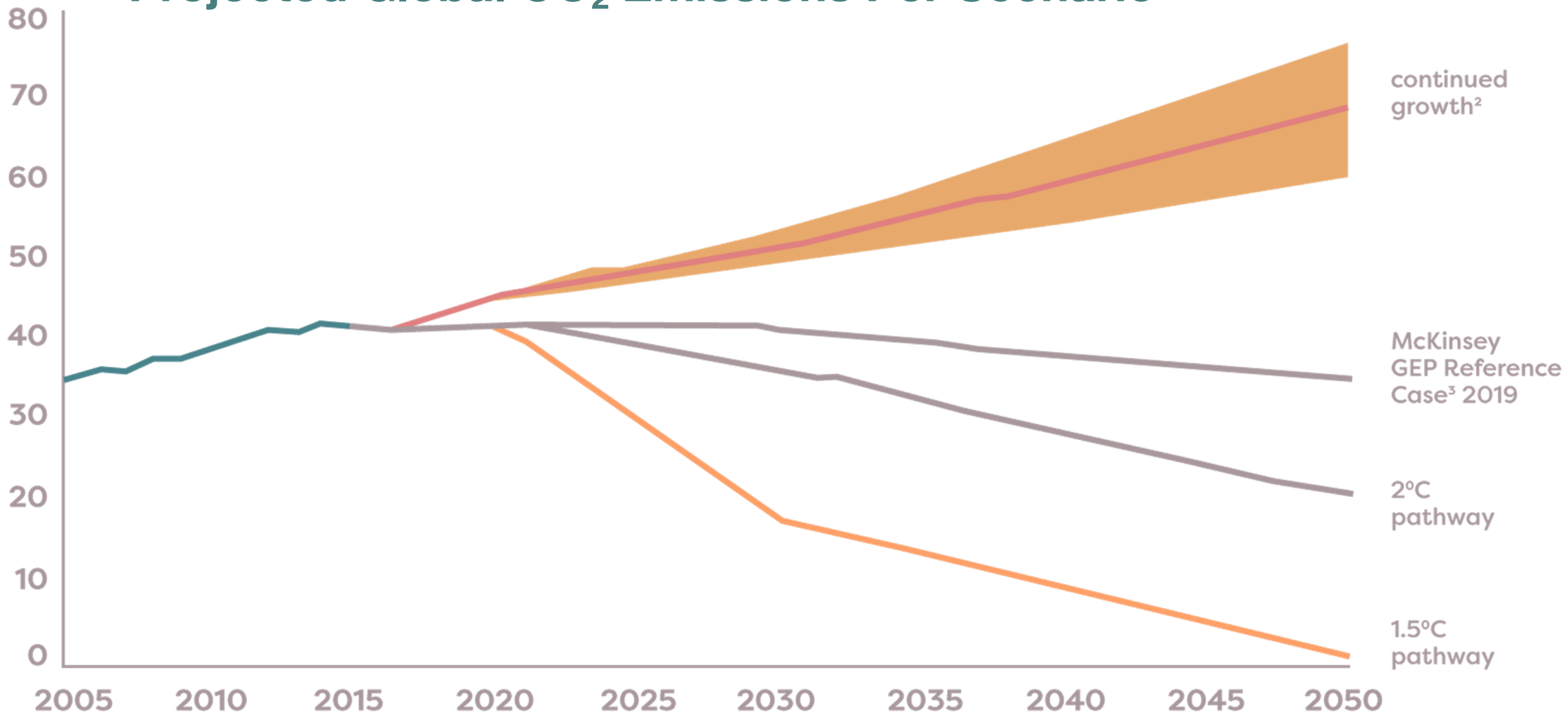
On behalf of the Drawdown Georgia team

Georgia Tech | University of Georgia | Emory University | the Ray C. Anderson foundation

What is our climate future?

Rapid declines in CO_2 emissions would be required to reach a 1.5 degree pathway

Projected Global CO_2 Emissions Per Scenario



McKinsey & Company, "Climate math: What a 1.5-degree pathway would take," McKinsey Quarterly, April 2020

Starting Point: Project Drawdown Solutions

PROJECT DRAWDOWN

email sign up | donate

View the solutions

ELECTRICITY GENERATION
- Biomass
- Cogeneration
- Concentrated Solar
- Energy Storage (Distributed)
- Energy Storage (Utilities)
- Geothermal
- Grid Flexibility
- In-Stream Hydro
- Methane Digesters (Large)
- Methane Digesters (Small)
- Micro Wind
- Microgrids
- Nuclear
- Rooftop Solar
- Solar Farms
- Solar Water
- Waste-to-Energy
- Wave and Tidal
- Wind Turbines (Offshore)
- Wind Turbines (Onshore)

FOOD
- Biochar
- Clean Cookstoves
- Composting
- Conservation Agriculture
- Farmland Irrigation
- Farmland Restoration
- Improved Rice Cultivation
- Managed Grazing
- Multistrata Agroforestry
- Nutrient Management
- Plant-Rich Diet
- Reduced Food Waste
- Regenerative Agriculture
- Silvopasture
- System of Rice Intensification
- Tree Intercropping
- Tropical Staple Trees

WOMEN AND GIRLS
- Educating Girls
- Family Planning
- Women Smallholders

BUILDINGS AND CITIES
- Bike Infrastructure
- Building Automation
- District Heating
- Green Roofs
- Heat Pumps
- Insulation
- Landfill Methane
- LED Lighting (Commercial)
- LED Lighting (Household)
- Net Zero Buildings
- Retrofitting
- Smart Glass
- Smart Thermostats
- Walkable Cities
- Water Distribution

LAND USE
- Afforestation
- Bamboo
- Coastal Wetlands
- Forest Protection
- Indigenous Peoples' Land Management
- Peatlands
- Perennial Biomass
- Temperate Forests
- Tropical Forests

TRANSPORT
- Airplanes
- Cars
- Electric Bikes
- Electric Vehicles
- High-speed Rail
- Mass Transit
- Ridesharing
- Ships
- Telepresence
- Trains
- Trucks

MATERIALS
- Alternative Cement
- Bioplastic
- Household Recycling
- Industrial Recycling
- Recycled Paper
- Refrigerant Management
- Water Saving - Home

COMING ATTRACTIONS
- A Cow Walks Onto A Beach
- Artificial Leaf
- Autonomous Vehicles
- Building With Wood
- Direct Air Capture
- Enhanced Weathering of Minerals
- Hydrogen-Boron Fusion
- Hyperloop
- Industrial Hemp
- Intensive Silvopasture
- Living Buildings
- Marine Permaculture
- Microbial Farming
- Ocean Farming
- Pasture Cropping
- Perennial Crops
- Repopulating the Mammoth Steppe
- Smart Grids
- Smart Highways
- Solid-state Wave Energy

21 High Impact Solutions

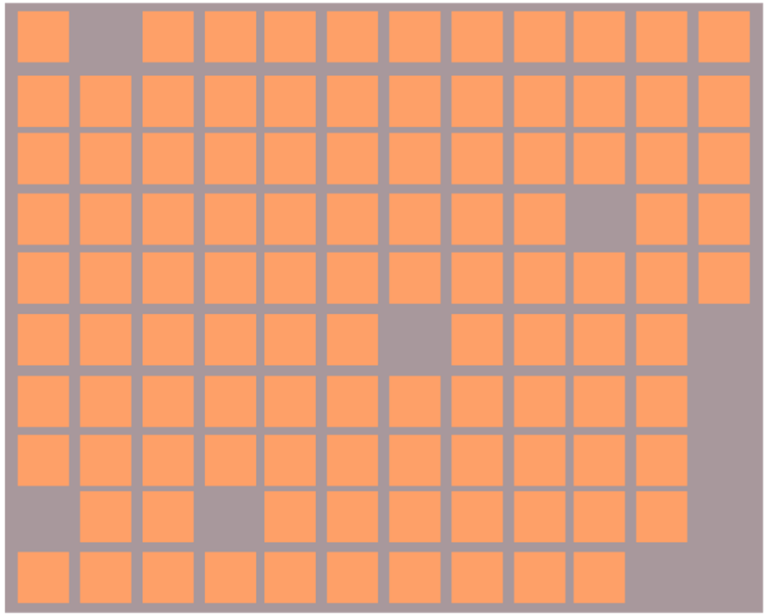
- Climate change presents real risks to Georgia and the rest of the world.
- Proactively managing those risks presents real opportunities.
- Addressing this challenge at scale will require creativity and innovation.
- Project Drawdown pioneered this type of new thinking at the global level.
- Drawdown Georgia brings a Georgia lens to this analysis.

https://www.exploregeorgia.org/article/georgias-famous-foods-you-just-have-to-try-when-you-visit

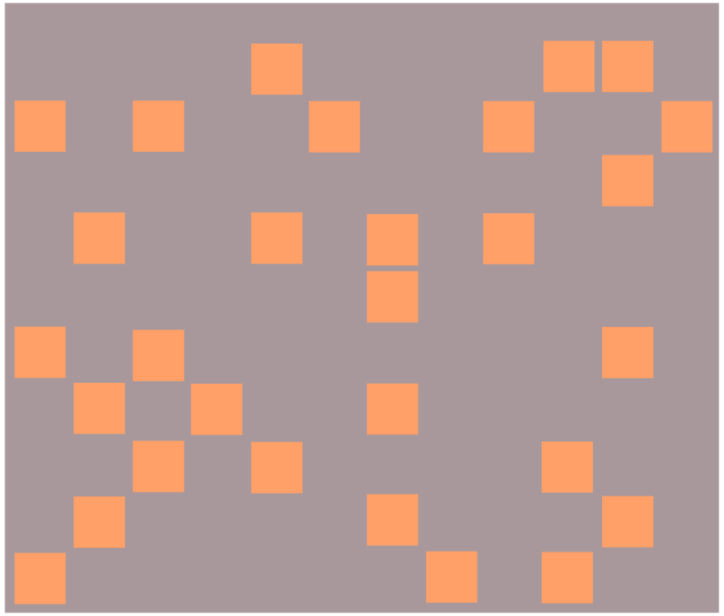
Down-Select Criteria:

- Is the solution technology & market ready for Georgia?
- Is there sufficient local experience and available data?
- Can the solution reduce 1 $MTCO_2e$ annually by 2030?
- Is the solution cost-competitive?
- What are the “beyond carbon” considerations?

PHASE 1



PHASE 2



A Working Paper and ~200-page appendix describing the “down-select” can be found here.

21 High-Impact Drawdown Georgia Solutions

Energy

Cogeneration	**Achievable**	Technical
Demand Response	Achievable	**Technical**
Rooftop Solar	**Achievable**	Technical
Solar Fields	Achievable	**Technical**
Landfill Methane	Achievable	**Technical**

Transportation

Aviation Groundworks	Achievable	**Technical**
Electric Vehicles	**Achievable**	Technical
Energy Efficient Cars	Achievable	**Technical**
Energy Efficient Trucks	Achievable	**Technical**
Mass Transit	**Achievable**	Technical
Alternative Mobility	Achievable	**Technical**

Food Systems

Composting	Achievable	**Technical**
Conservation Agriculture	**Achievable**	Technical
Plant Rich Diet	Achievable	**Technical**
Reduced Food Waste	Achievable	**Technical**

Built Environment & Materials

Recycling	Achievable	**Technical**
Refrigerant Management	**Achievable**	Technical
Retrofitting	Achievable	**Technical**

Forests & Land Use

Afforestation & Silvopasture	**Achievable**	Technical
Coastal Wetlands	Achievable	**Technical**
Temperate Forest Protection & Mgmt	**Achievable**	Technical

Drawdown Scenarios of the 21 High-Impact Solutions

Baseline Forecast = The "no new action" scenario – the status quo + changes and trends already underway.

Achievable Potential: A more optimistic scenario still considering costs, impacts, and stakeholder acceptance, but consistent with a greater commitment to success.

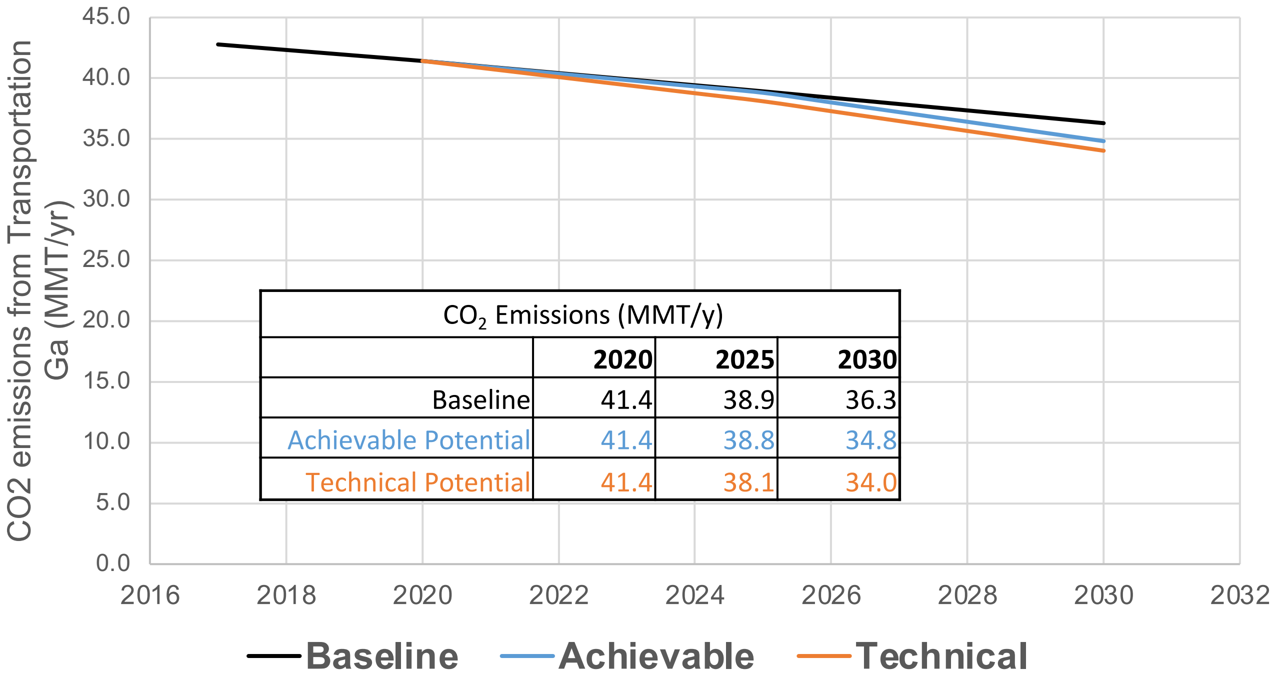
Growing solar fields from 1 to 11% of electricity generated, EVs are 15% of new sales by 2030.

Technical Potential: Maximum realistic application without regard to cost or other impacts, up to hard limits on resources such as available land and materials.

Increasing forest cover by 10%, recycling 95% of disposed recyclable materials.

Electric Vehicles

EVs can contribute additional CO_2 reductions beyond a favorable baseline trend by 2030



CO_2 Emissions (MMT/y)			
	2020	**2025**	**2030**
Baseline	41.4	38.9	36.3
Achievable Potential	41.4	38.8	34.8
Technical Potential	41.4	38.1	34.0

1 $MtCO_2e$ solution in 2030 = ~250,000 cars taken off the road

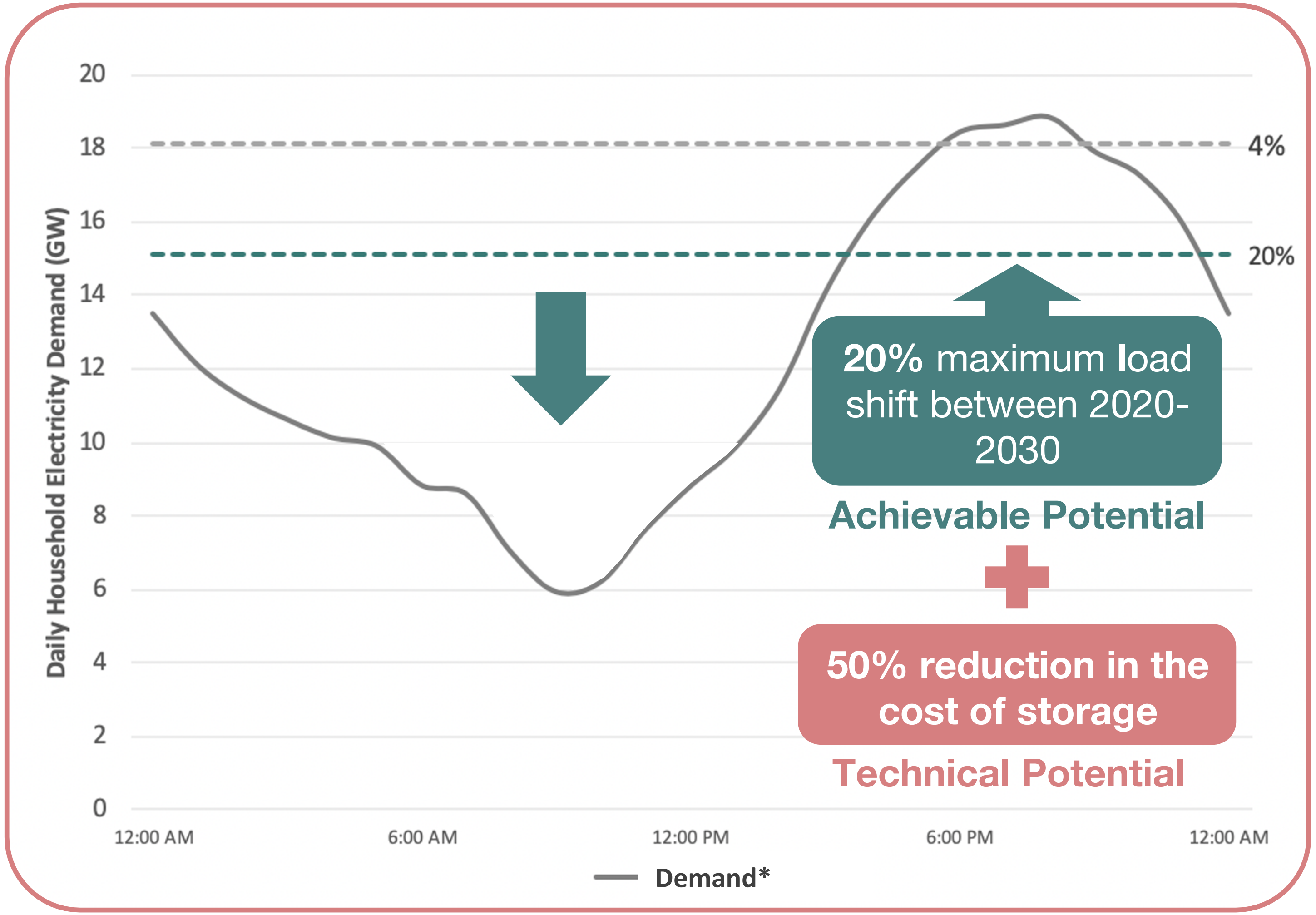
+ Improved Air Quality
+ Approaching TCO price parity
+ Lower operating and maintenance costs
- Affordability on capital cost basis

Baseline = Assumes business as usual for fuel economy and CO_2 reductions, driven by new vehicle technologies and Federal CAFÉ regulations

Achievable Potential =Approximately **310,000** electric vehicles in the Georgia Light Duty Vehicle Fleet (i.e., about 4% of the total fleet), and accounting for 15% of new LDV sales in 2030

Technical Potential = Approximately **680,000** EVs in the Georgia LDV fleet (9% of the total fleet), and 35% of new LDV sales by 2030. Contributing **2.3MMT/yr** in CO_2 reductions compared to baseline.

Demand-Side Response Achievable & Technical Methodology



*Georgia Power designated on-peak months Jun-Sep

For the three scenarios approximately 100 on-peak hours were modeled by GT-NEMS with the following parameters set for each.

Under the baseline forecast, a maximum load shift of **4%** is assumed.

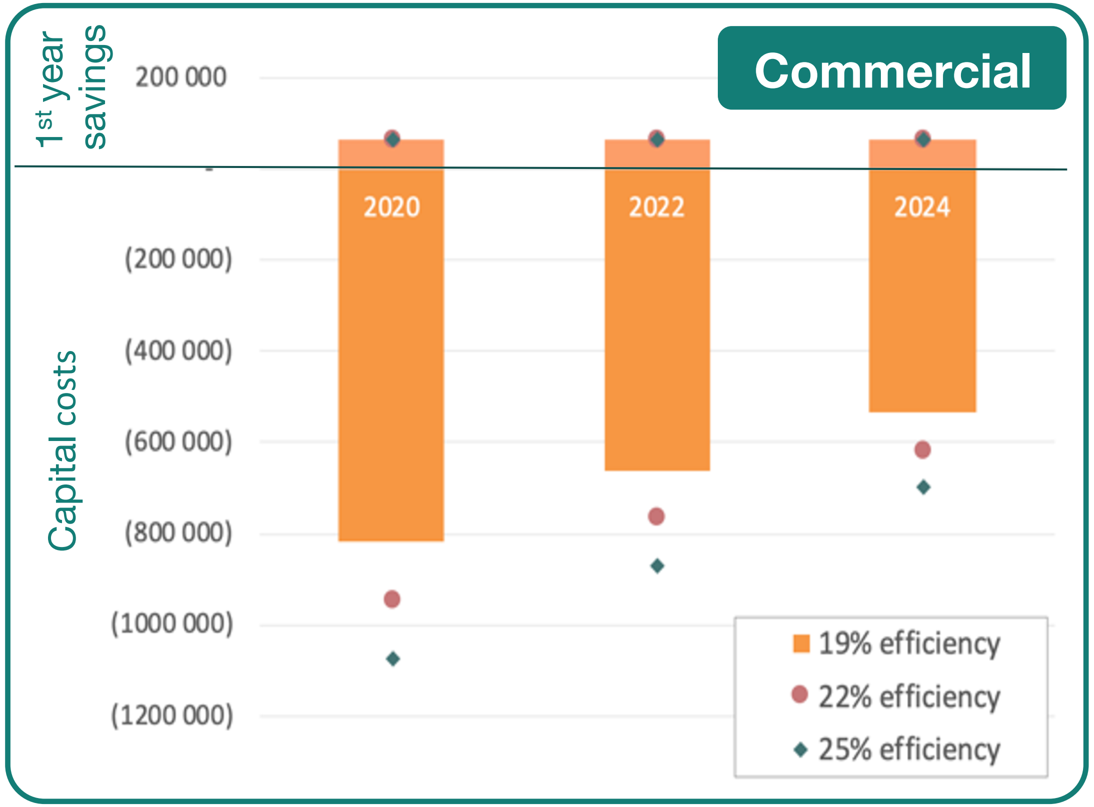
The achievable potential increases the maximum load shift to **20%** between 2020 and 2030.

The larger technical potential, in addition to the **20%** maximum load shift, also models for a **50%** reduction in the cost of storage.

Costs and Benefits of Rooftop Solar Installations

Improvements in efficiency and costs leading to greater net-present value

Source: System Analysis Model (SAM) results



Residential payback periods:

15.2 - 15.8 years in 2020
12.7 - 13.3 years in 2022
10.6 - 11.1 years in 2024

Commercial payback periods:

9.3 -12.6 years in 2020
7.6 - 10.3 years in 2022
6.1 - 8.4 years in 2024

Challenges and Promising Policies

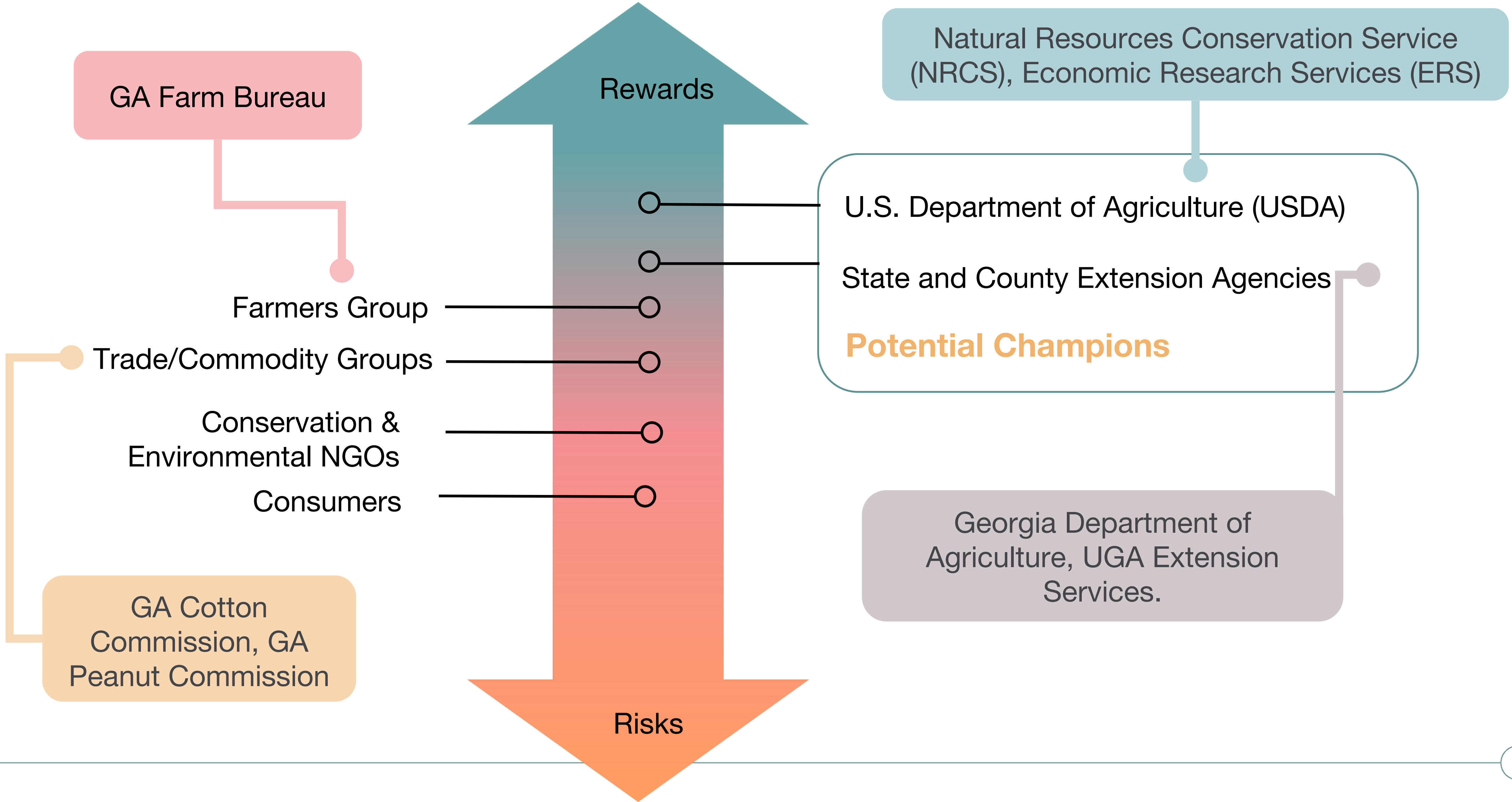
Challenges

- High upfront costs
- Information asymmetry
- Transaction and administrative costs
- Principal-agent problems
- Split/misplaced incentives and subsidies.
- Lack of a decoupling policy in Georgia
- Issues arising from discount rates of individuals and businesses

Promising Policies

- Electricity decoupling, providing easier access to capital at attractive interest rates
- Programs such as on-bill financing and property assessed clean energy (PACE)
- Information campaigns to reduce information asymmetry
- Improved standards
- Information campaigns to promote more energy-efficient replacements of equipment at end-of-life

Stakeholder Analysis of Conservation Agriculture



Solar Fields

Electric Vehicle

- Solar fields enable EVs to lower their CO_2 emissions.

Cogeneration

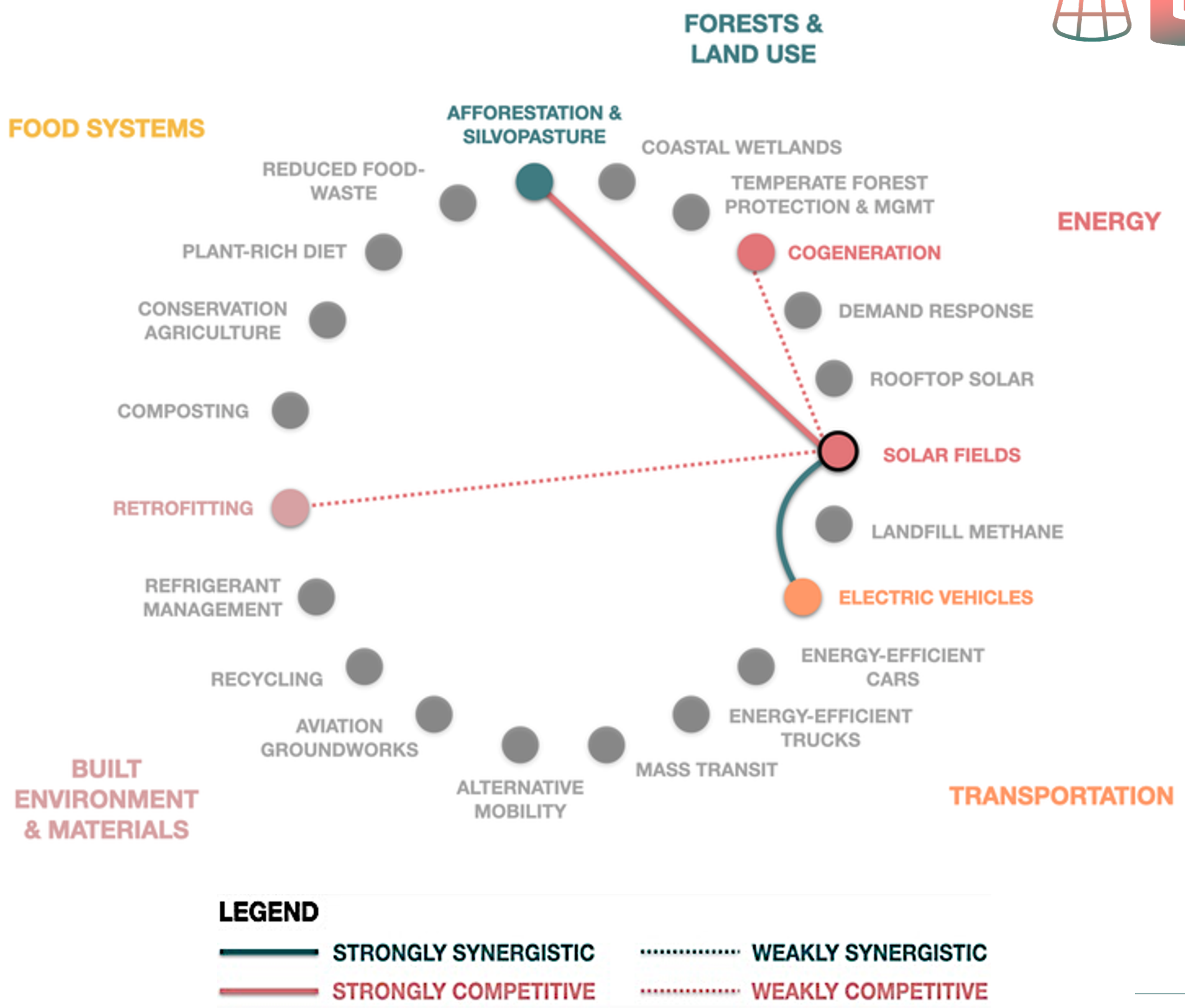
- A potentially more affordable low-carbon electricity option.

Retrofitting

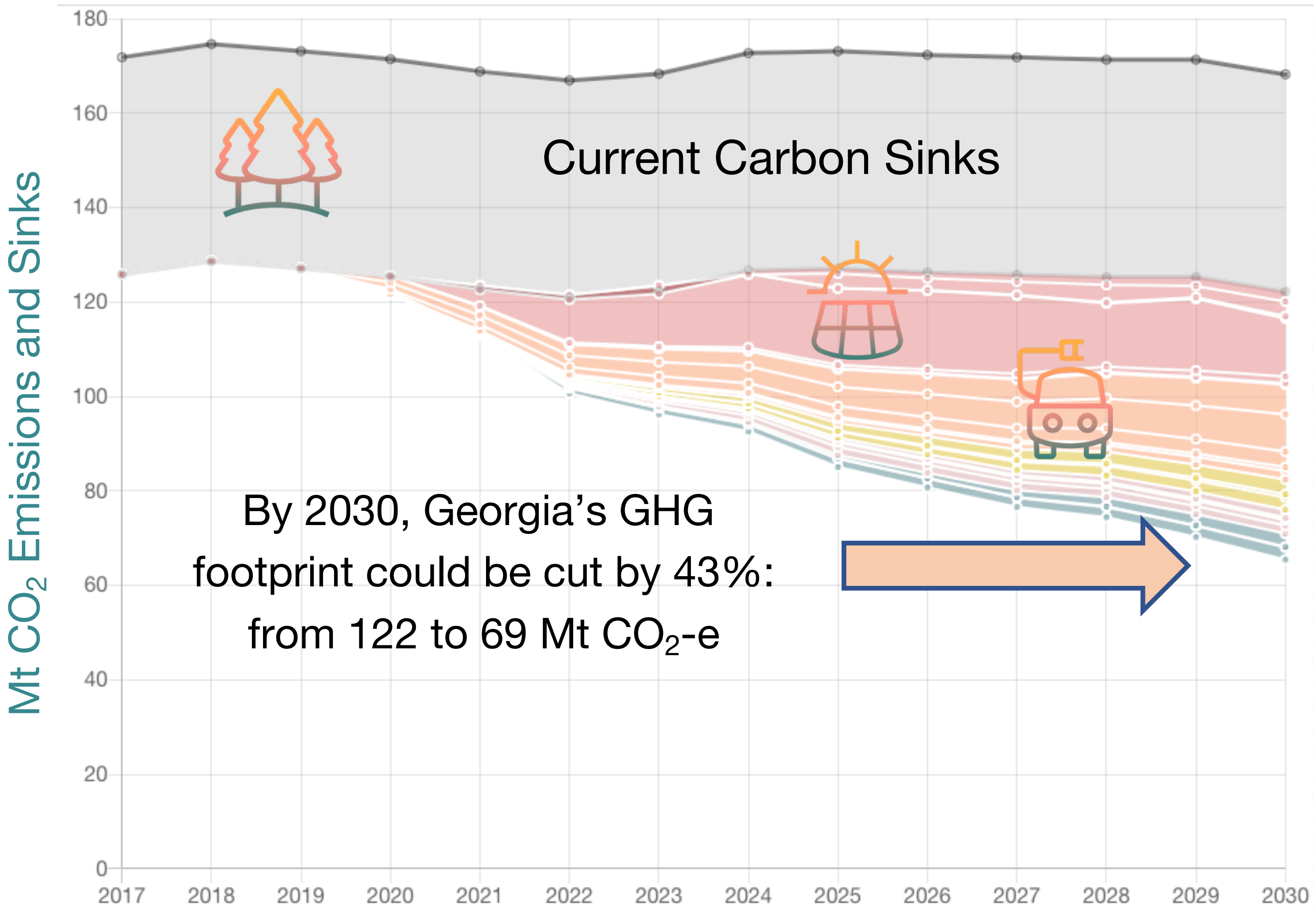
- With lots of solar fields, retrofitting buildings saves less carbon.

Afforestation & Silvopasture

- New solar fields would occupy lands that otherwise could be used for growing trees or crops.

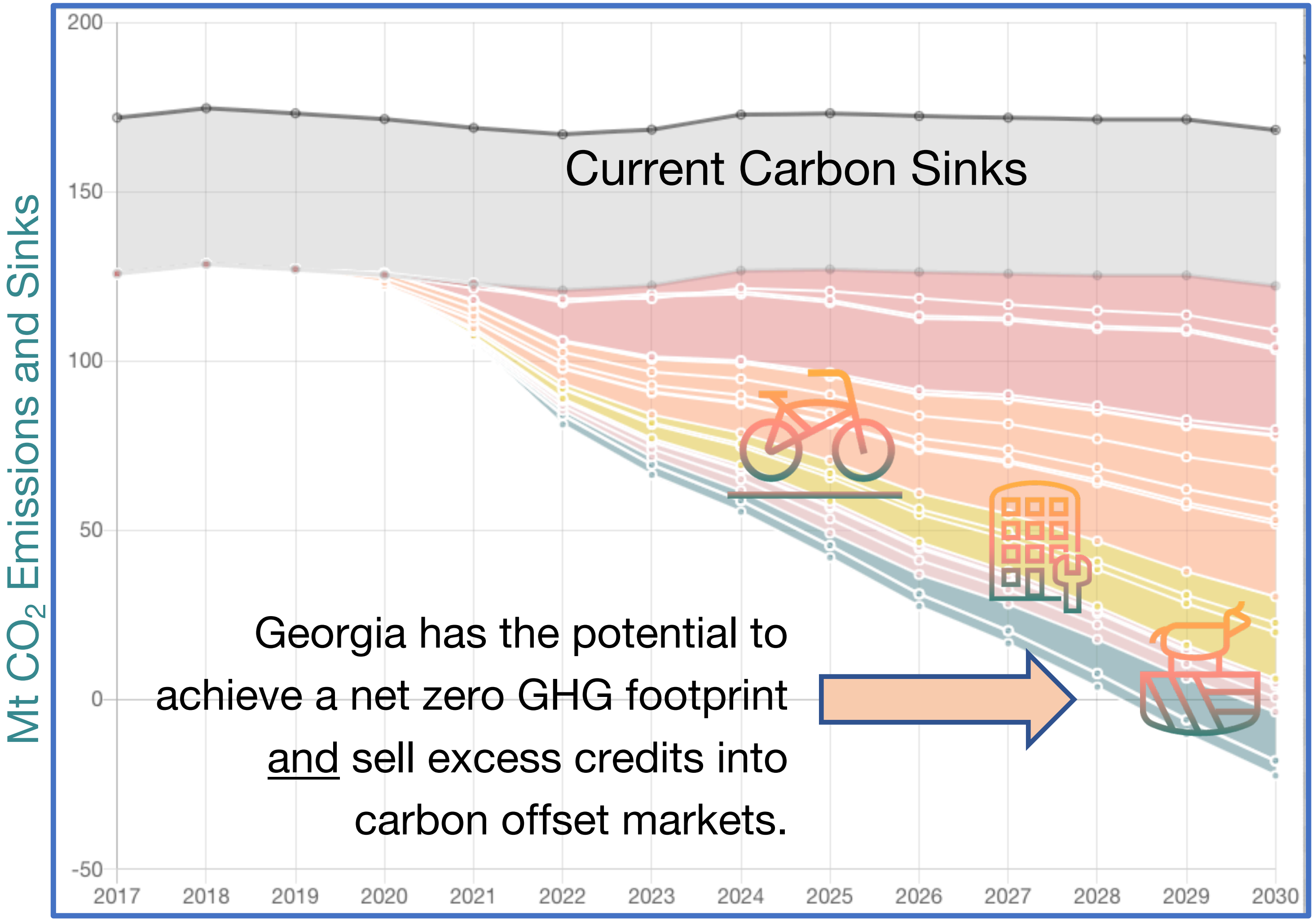


Wedge Diagram – Achievable Potential



- Shows annual Mt CO_2 reductions relative to the Baseline (black) and current carbon sinks.
- Includes baseline annual sequestration (grey) at 46 Mt CO_2 per year from Georgia's natural carbon sinks
- All 21 solutions are set to their achievable potential
- Electric vehicles in this model are enhanced by solar fields, with more such overlaps yet to be added.

Wedge Diagram – Technical Potential



- All 21 solutions are set to their technical potential
- Carbon emissions reduced by 118% in 2030.
- Electric vehicles in this model are greatly enhanced by solar fields.
- More such overlaps yet to be added.

DRAWDOWN GEORGIA ORGANIZATIONAL CHART

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Rooftop Solar

Presenter
Dr. Marilyn Brown, Georgia Institute of Technology

Lead Analysts
Dr. Marilyn Brown and Vincent Gu
Georgia Institute of Technology

Rooftop Solar

Current Capacity:
5.9 MW (4.0 MW from Solarize Programs)

Technical Potential: Reduction of
3.7 Mt CO_2 in 2030

Achievable Potential: Reduction of
0.8 Mt CO_2 in 2030

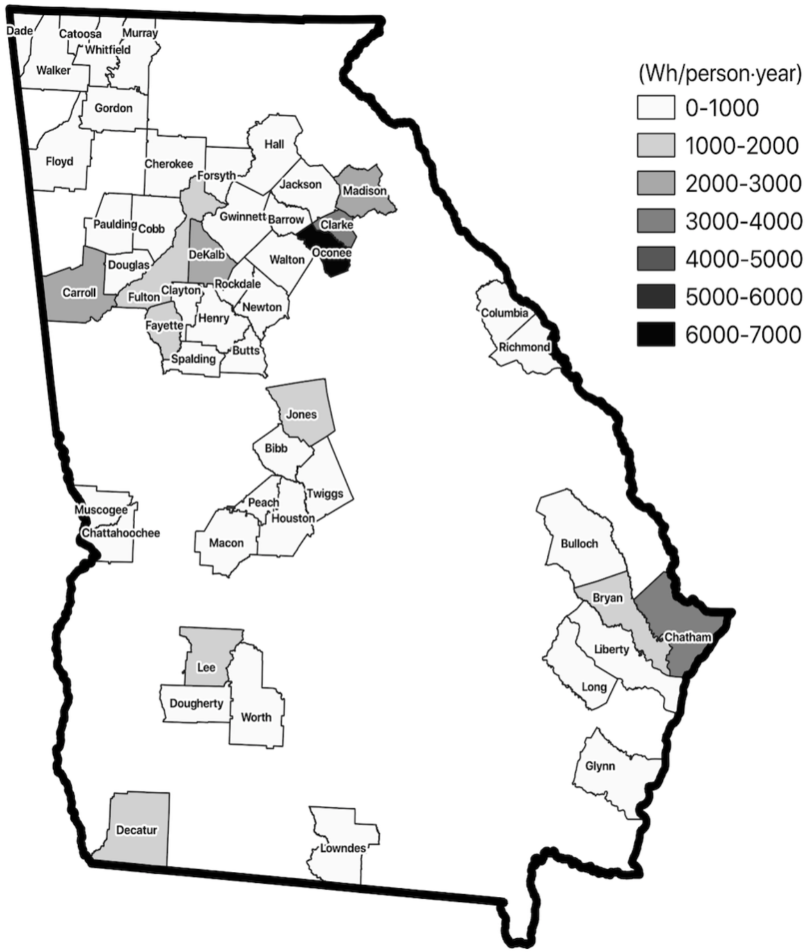
Most of the existing capacity is in large cities: Atlanta, Savannah and Athens

Key obstacles:

- High capital costs
- Buyback rates = relatively low retail rates
- Fees and cumbersome permitting procedures

Current growth is driven by community campaigns that:

- Reduce costs through bulk purchasing
- Streamline procedures

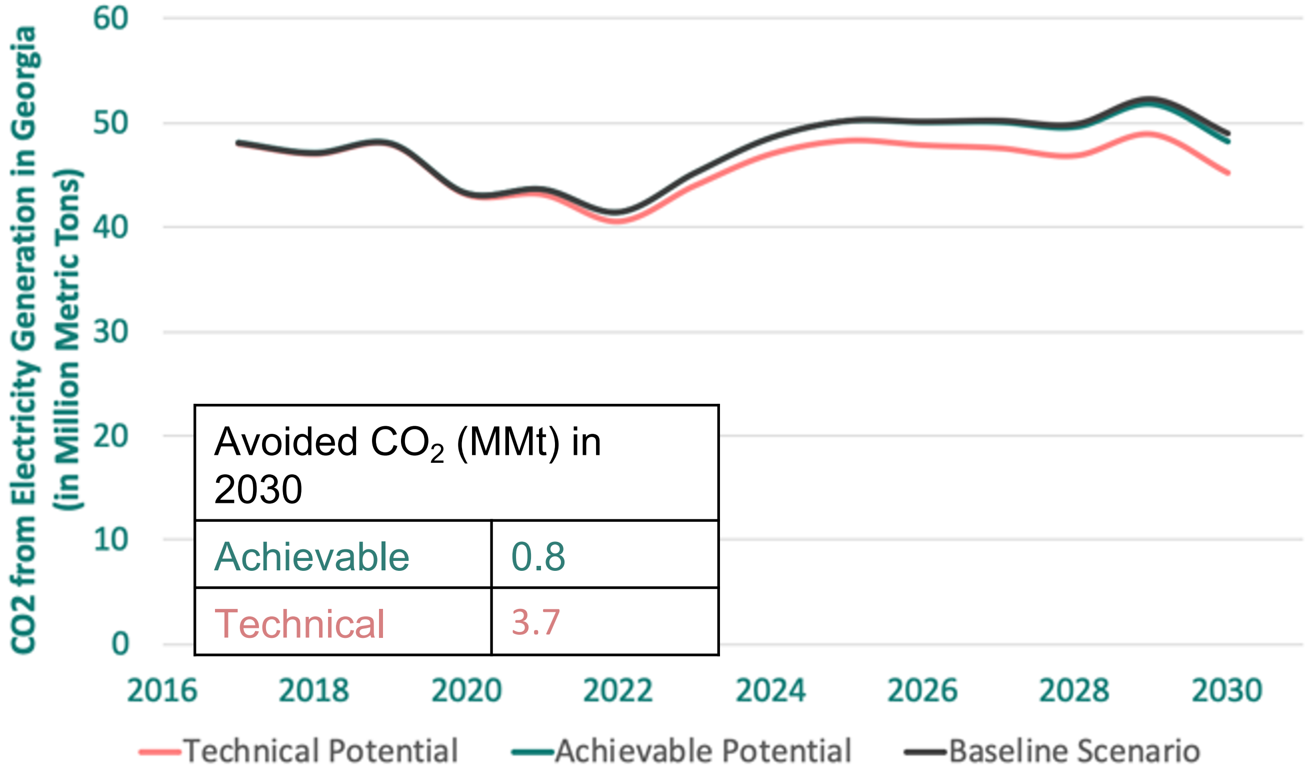


Solar PV on Georgia rooftops in 2019

Source of data: Google Project Sunroof

Rooftop Solar

A gradual learning curve, with Solarize campaigns and PulteHomes as first-movers



Avoided CO_2 (MMt) in 2030	
Achievable	0.8
Technical	3.7

Baseline = GT-NEMS forecasts a 6.4 $MtCO_2$ rise in yearly emissions by 2030.

Achievable Potential = Reduction of **0.8 $MtCO_2$** in 2030, totaling 2.1 $MtCO_2$ between 2020 and 2030.

Technical Potential = Maximum south-facing rooftop capability of abating **3.7 $MtCO_2$**, flattening the growth of CO_2 in GA over the decade

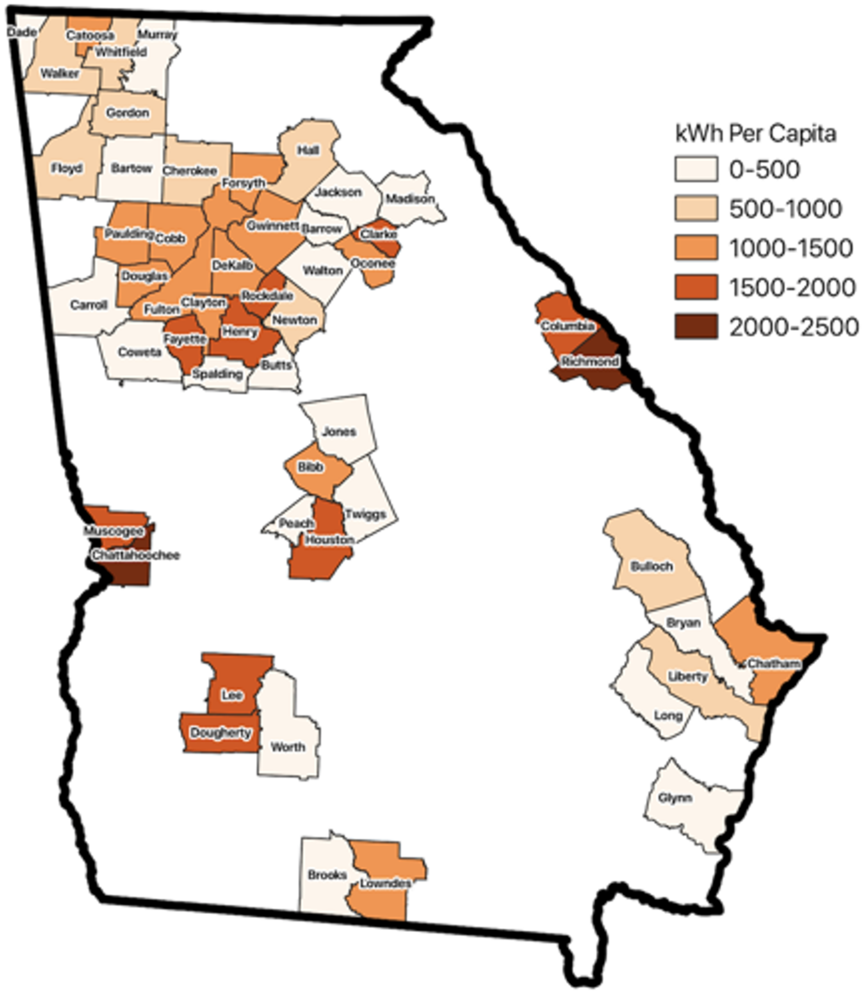
1 $MtCO_2e$ solution in 2030 = **2,580 GWh** of zero-carbon generation from solar panels

7.2 GW available capacity from south-facing rooftops
4.01 MW current installed capacity from Solarize
11-year residential payback period anticipated mid-2020's

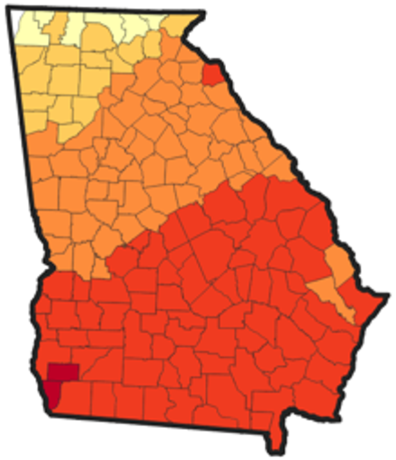
+ Enhanced reductions with electric vehicles and demand-side response
+ Less air pollution
– High capital costs
– Low buyback rates in GA

Rooftop Solar Technical Potential

Substantial reductions possible by 2030



Rooftop PV Generation Potential per Capita



Solar radiation levels
(208 to 228 W/m^2)

5,858 kW existing rooftop capacity in 2019

4,008 kW capacity installed from **Solarize** projects

Technical Potential

47.35 km^2 available space from south-facing rooftops

7.2 GW total available capacity

9,153 GWh annual generation capacity

3.7 $MtCO_2$ annual reduction (1 MMt per 2,580 GWh)

Source: Authors, based on Google Project Sunroof data explorer (March 2020)

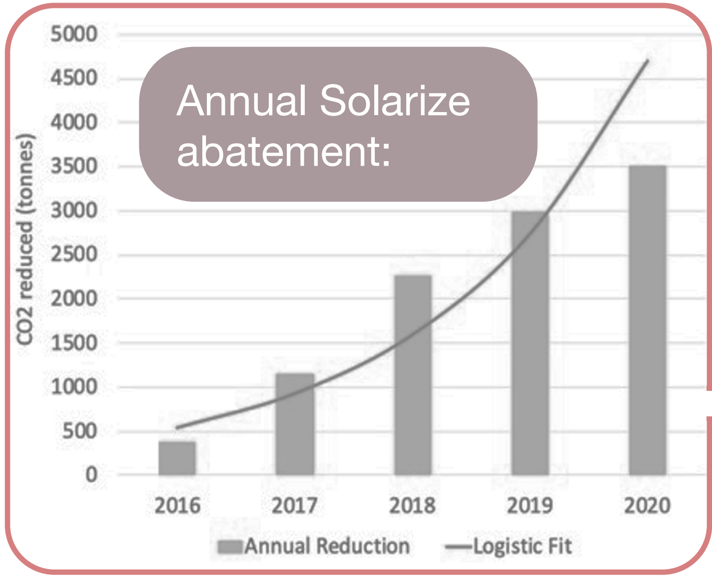
Rooftop Solar Achievable Potential

Substantial reductions possible by 2030

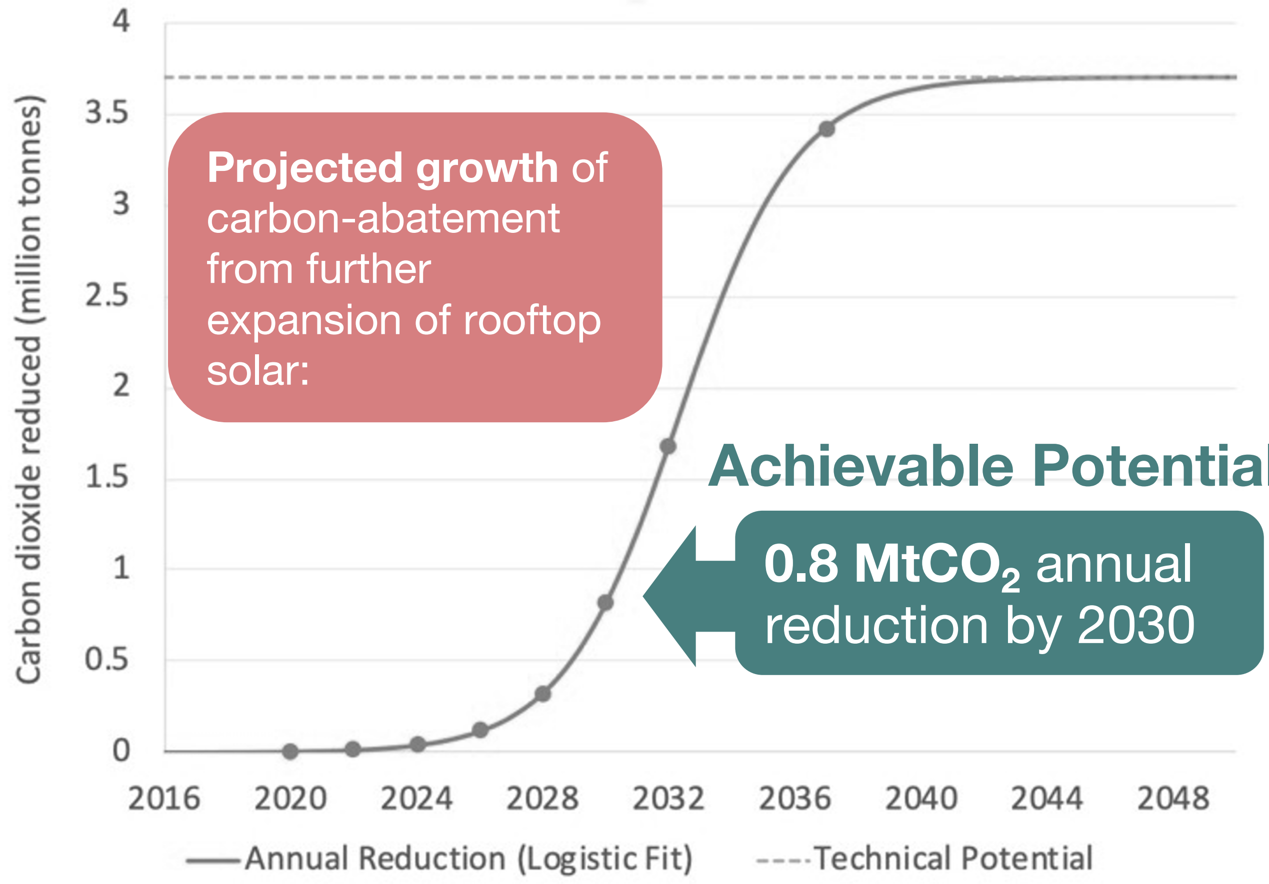
5,858 kW existing installed rooftop capacity

4,008 kW capacity installed from **Solarize** projects

Annual Solarize abatement:



Projected growth of carbon-abatement from further expansion of rooftop solar:



Achievable Potential

0.8 $MtCO_2$ annual reduction by 2030

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Demand-Side Response

Presenter
Dr. Matt Cox, The Greenlink Group

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Georgia Institute of Technology

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Why Demand-Side Response?

Demand-side response is a tool for clipping expensive and polluting demand peaks and tackling the intermittency of variable renewable energy in Georgia.

DSR can facilitate the integration of more solar energy, when coupled with:

- battery storage
- smart devices
- direct load control
- real-time pricing

Altus at the Quarter by Pulte Homes (Atlanta)

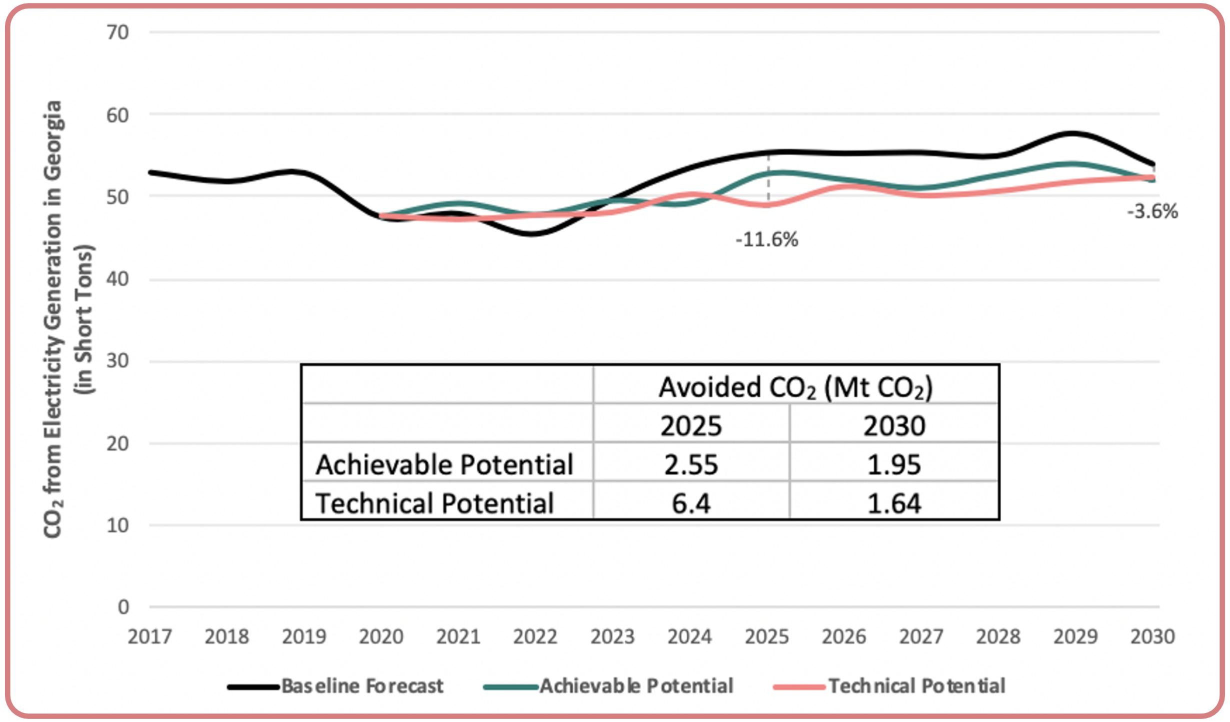
Puck programmable Thermostat

Garage with two 5 KW lithium-ion batteries, an EV charger, and a heat pump water heater

SiteSage circuit monitoring system

Demand-Side Response

Our working scenarios suggest sizable carbon mitigating potential by 2030



	Avoided CO_2 (Mt CO_2)	
	2025	2030
Achievable Potential	2.55	1.95
Technical Potential	6.4	1.64

Baseline = GT-NEMS forecasts a 6.4 MtCO_2 rise in yearly emissions by 2030.

Achievable Potential = Reduction of **2 MtCO_2** in 2030, totaling **19.1 MtCO_2** between 2020 and 2030.

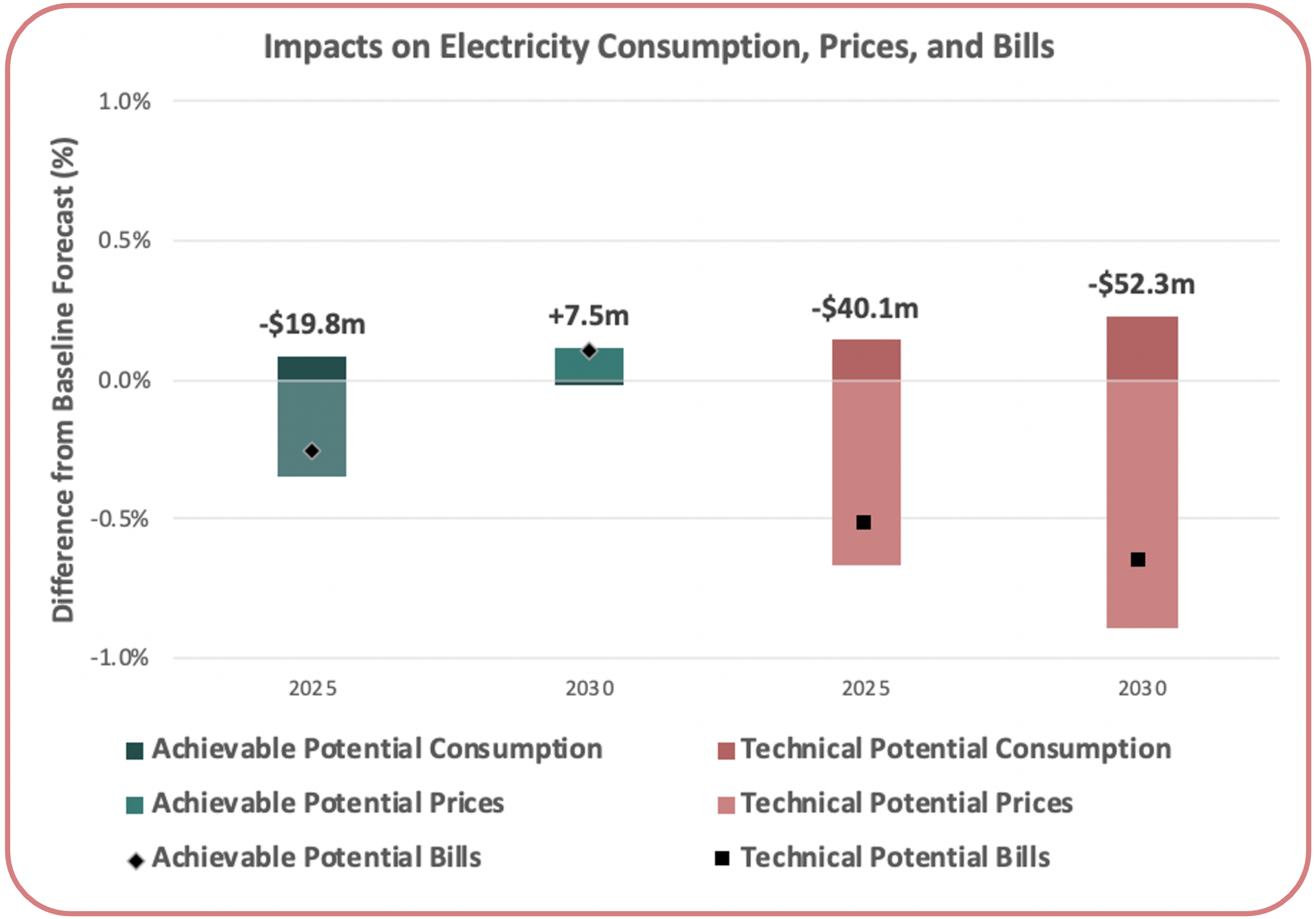
Technical Potential = Reduction of **1.6 MtCO_2** in 2030, totaling **31.3 MtCO_2** between 2020 and 2030.

+ Bill savings for Georgia households
+ Low capital costs
+ Enables greater integration of solar
+ Less air pollution
-/+ Costs/tCO_2 averted = yearly average of $5 to $6

1 MtCO_2e solution in 2030 = **187,000** households participating in a DSR program, shift 10% of their peak to off-peak demand.

- 8.5% of households served by Georgia Power.
- 4.39 kW peak load per household.

Georgia Households would see Lower Prices and Bills for the Same Levels of Consumption



Baseline = Prices increase from 11.9¢/kWh in 2017 to 13.4¢/kWh by 2030.

Achievable Potential = Prices increase to **13.4¢/kWh** by 2030 but average **0.15%** lower over the decade, saving Georgia households approximately **$87 million.**

Technical Potential = Prices increase to **13.2¢/kWh** by 2030 averaging **0.51%** lower over the decade, saving Georgia households approximately **$330 million.**

Demand-Side Response

A solution for Georgia that

- Reduces carbon emissions
- Saves consumers money
- Features low costs for utility providers
- Is compatible with other solutions

Georgia Tech   UNIVERSITY OF GEORGIA   EMORY UNIVERSITY   the RAY C. ANDERSON foundation

DRAWDOWN GA

Composting

Dr. Sudhagar Mani
University of Georgia

Composting

Current Capacity:
2.6 million tons of organic wastes landfilled

Technical Potential:
Reduction of
0.7 Mt CO_2 in 2030

Achievable Potential:
Reduction of
1.4 Mt CO_2 in 2030

- Biological aerobic process to decompose organic wastes by microorganisms into stable organic materials - compost
- A valuable soil conditioner or fertilizer that improves plant growth, sequester soil carbon and prevents soil erosion
- Scale ranges from commercial, community to home composting sizes. Georgia currently operates about 38 composting facilities at various commercial scales
- Key obstacles include lack of awareness, large initial investment and operating costs, odor issues and contamination

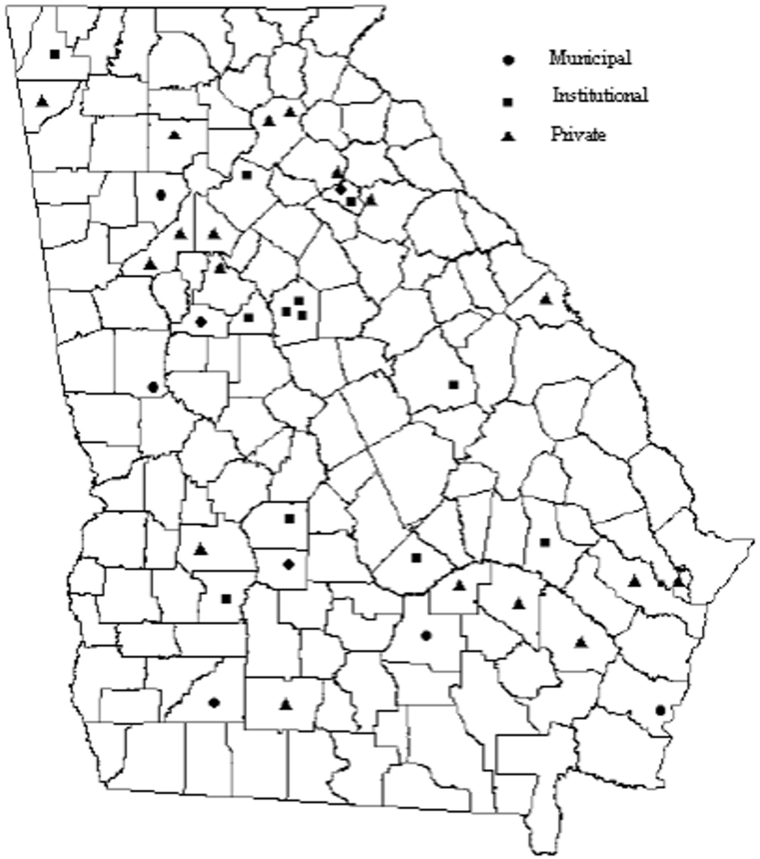
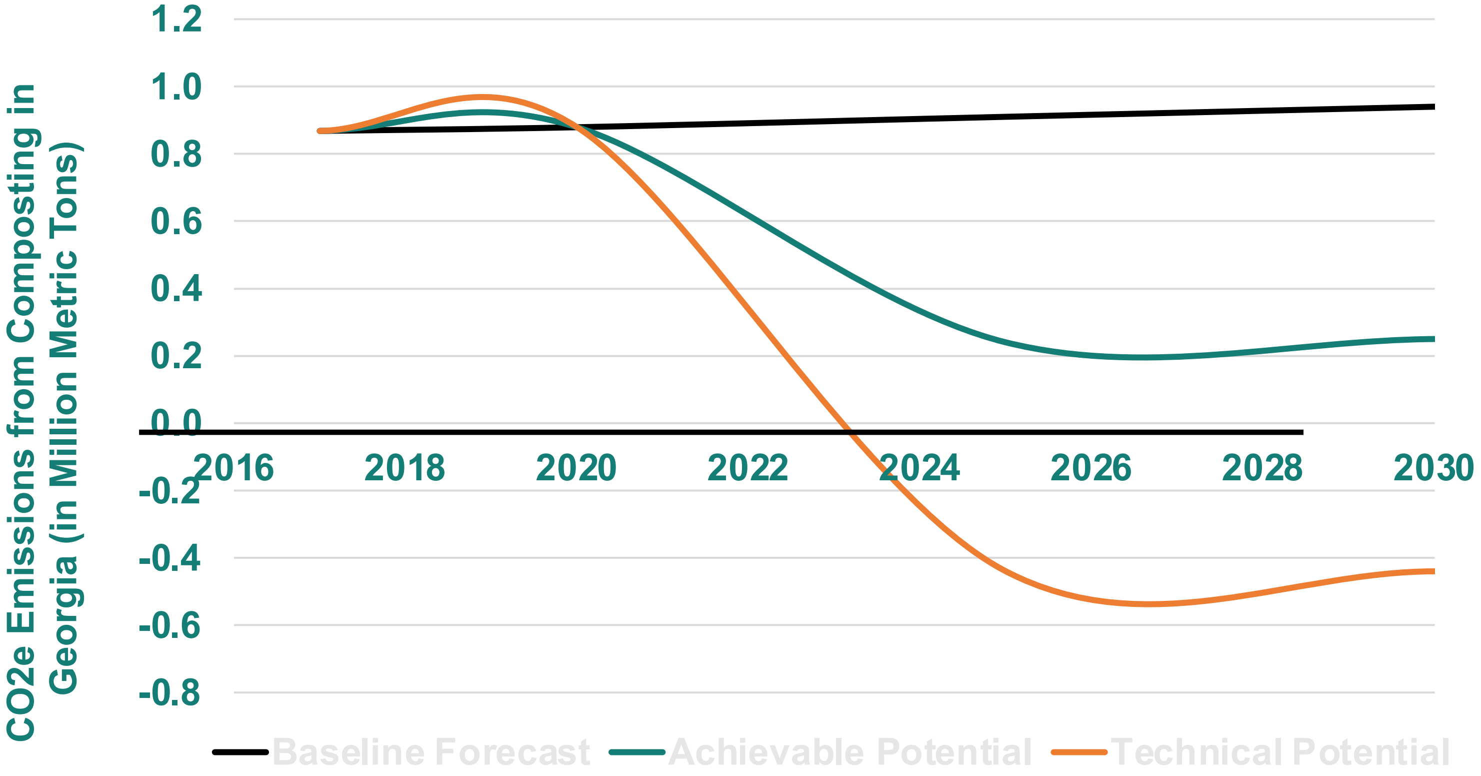


Figure 1: Location of 38 Georgia composting facilities, which participated in the survey, represented as municipal, institutional and private operations

Source: GA EPD

Composting

A simple solution to zero landfill Georgia



Baseline = Estimate based on the emissions due to landfilling of organic wastes including food waste.

Achievable Potential = 50% diversion of organic wastes from landfill reduce **0.7 $MtCO_2$** in 2030,

Technical Potential = Complete diversion of organic wastes from landfill reduces **1.4 $MtCO_2$** in Georgia

Avoided CO_2 (MMt) in 2030	
Achievable	0.7
Technical	1.4

+ More job creation
+ Less air and water pollution
– High capital and operating costs
– Odor issues

Annually, about 2.6 million tons of organic wastes including food waste are landfilled in Georgia

Circular Organic Wastes Management in Georgia

A promising solution

- **Centralized composting** with federal and state grants and private investments will reduce costs and promotes widespread deployment across the state (-source-separation collection)
- **Home composting** can be cheaper to residents and can save from waste disposal costs (-packaging materials)
- **Organic fertilizer** can displace fossil derived fertilizers for crop production
- **Compost** promotes organic agriculture and urban gardening practices

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Electric Vehicles

Dr. Richard Simmons
Georgia Institute of Technology

Georgia Tech · University of Georgia · Emory University · The Ray C. Anderson Foundation

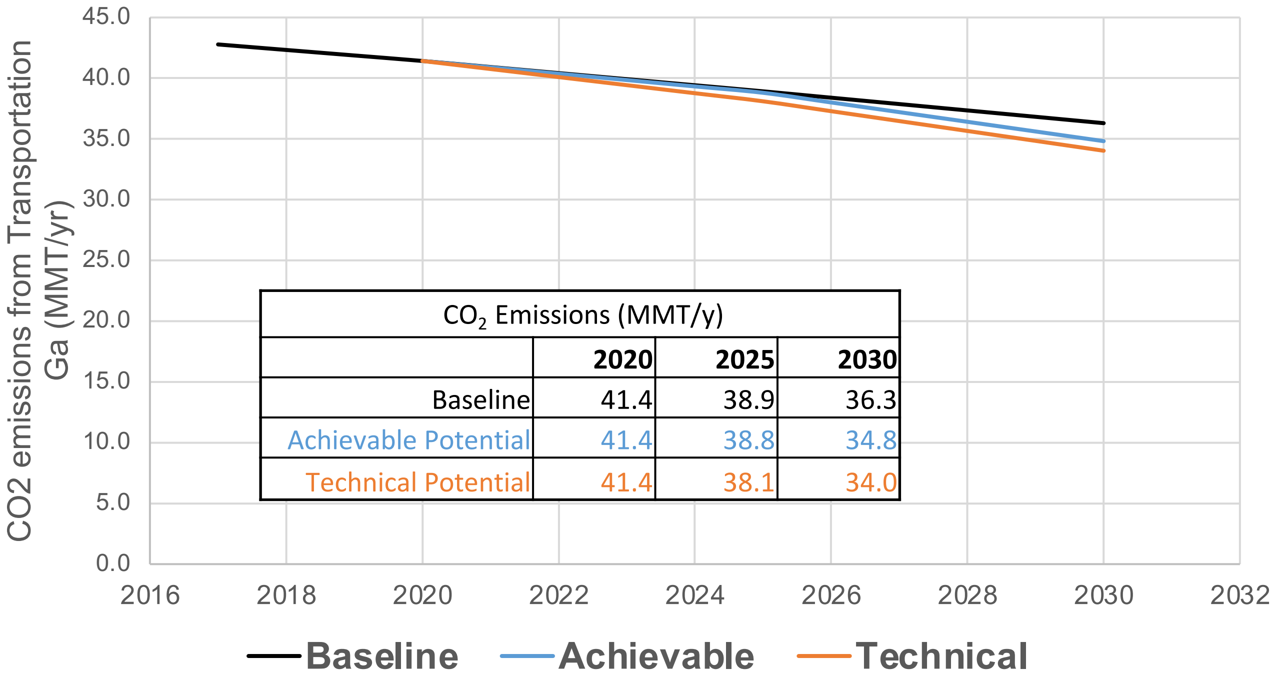
Electric Vehicles

Electric vehicles (EVs) are powered by electric batteries instead of conventional fuels such as gasoline and diesel. The emissions profile of these vehicles is lower, however the exact emissions vary depending on the generation mix providing the electricity.

In this Drawdown GA solution, we assess the CO_2 reduction potential of EVs in the light duty vehicle category. However, electrification is an option that can provide CO_2 benefits in additional vehicle segments including MD/HD truck, public transit, and aviation groundworks.

Electric Vehicles

EVs can contribute additional CO_2 reductions beyond a favorable baseline trend by 2030



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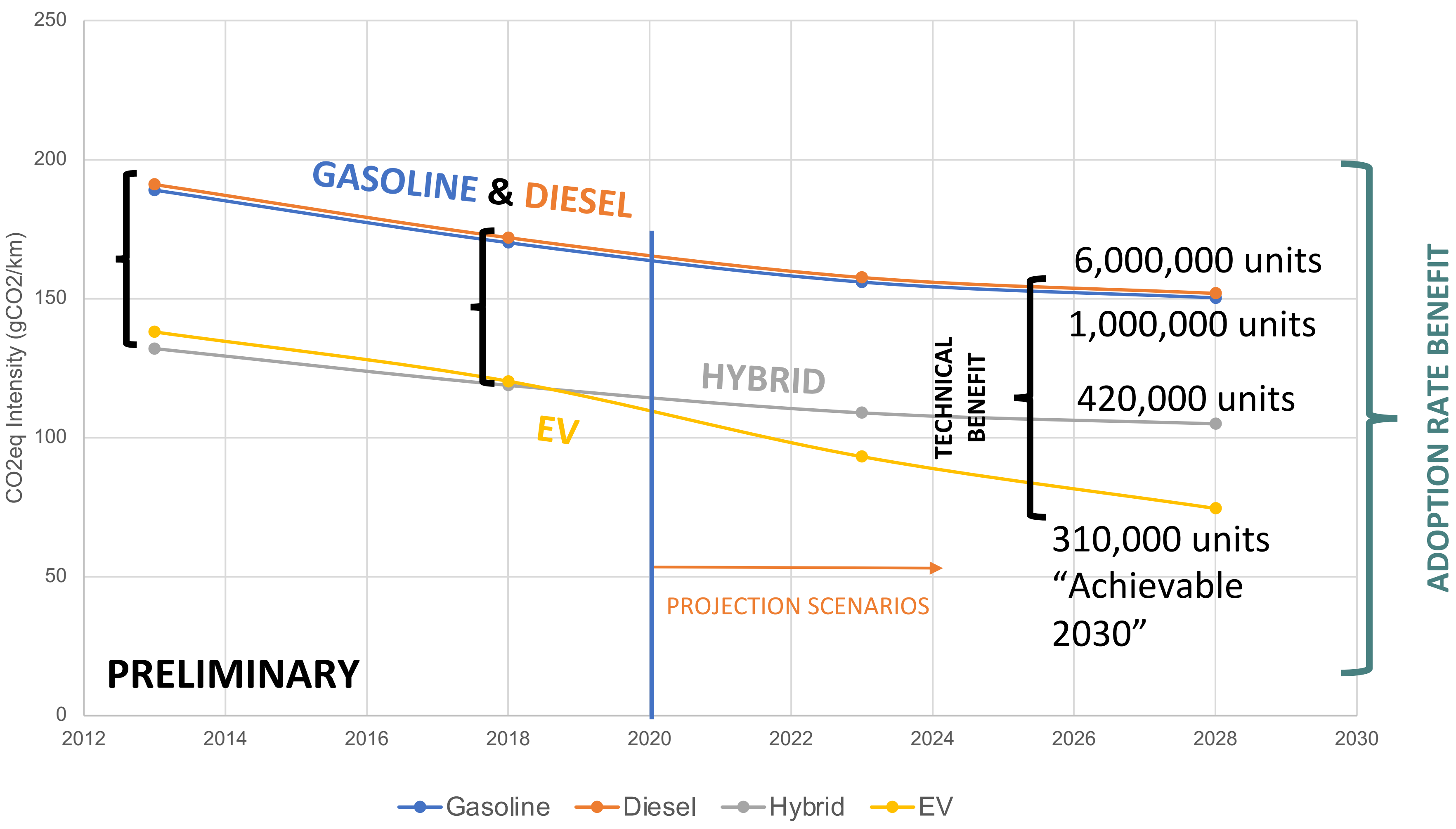
Grid CO_2 intensity reductions propel per vehicle EV contributions

Despite an aggressive baseline



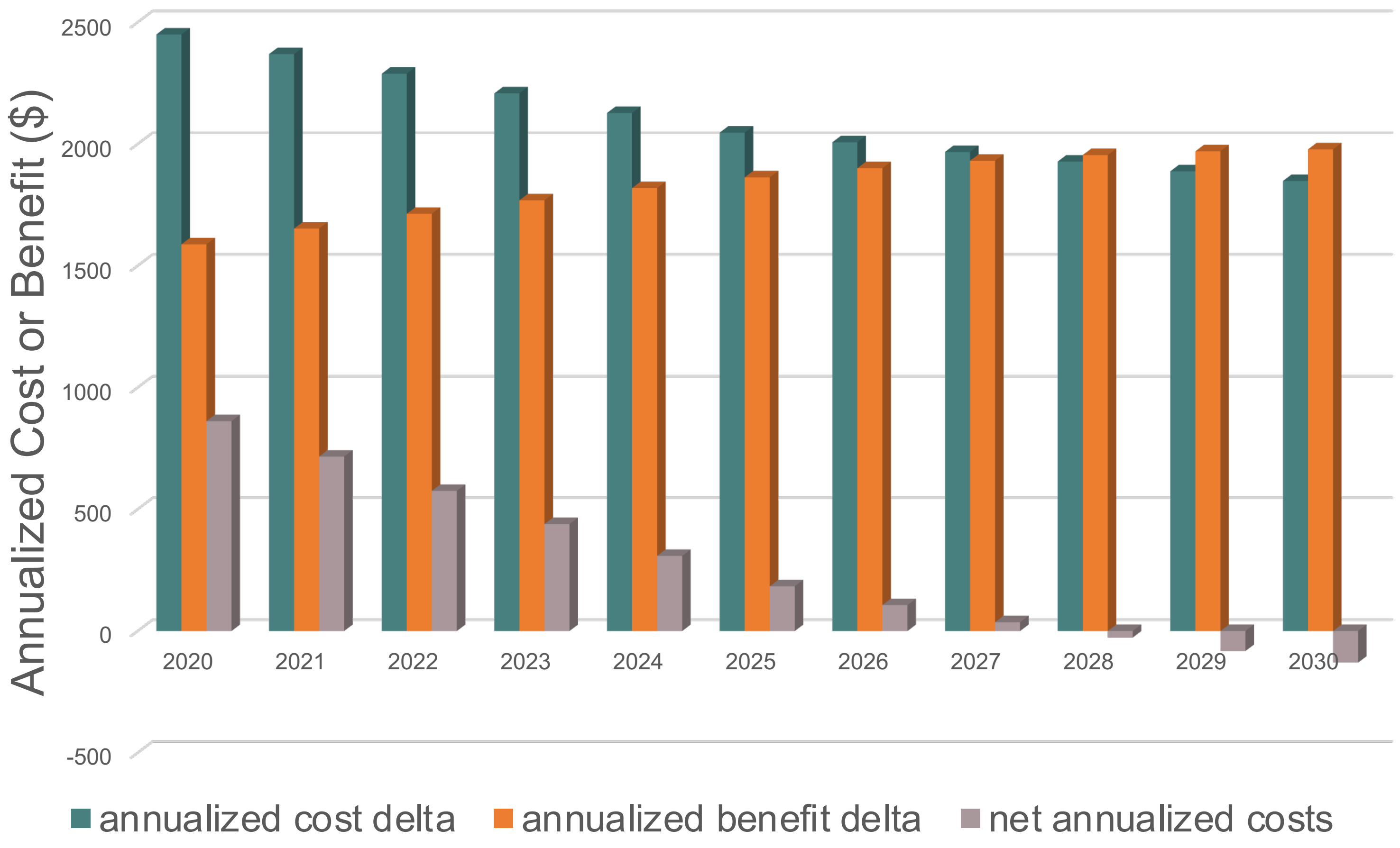
R. Simmons, Strategic Energy Institute, Georgia Institute of Technology, 2020

Conventional vehicles improve at 1.5% y/y through 2025

EVs approach a relative CO_2 intensity of 50% compared to conventional cars

But, adoption rate will dictate overall impact from this solution

EV costs approach price parity by 2030 on TCO basis, with qualifiers



New EV sticker prices are currently more than similar conventional cars.

Subsidies currently offset most of this differential. In the next decade, price parity is anticipated on a total cost of ownership basis.

However, a few significant unknowns remain:

- Continued decline in battery prices
- Cost of conventional fuel
- Cost of charging equipment
- Federal/State EV tax credits
- Interest rates and financing costs
- Carbon policy
- CAFE regulations

Electric Vehicles

A solution for Georgia that

- Reduces carbon emissions
- Is synergistic with a cleaner grid
- Results in air quality benefits
- Helps diversify transportation energy resources
- Can generate new jobs

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Retrofitting the Built Environment

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Retrofitting

We asked a focus group about the following technologies for retrofitting:

- Improving air sealing/insulation
- LED lighting
- High-efficiency heat pumps & water heaters
- Smart thermostats
- Automated control systems
- Water-saving devices
- Alternative roof designs (green roofs or cool roofs)
- Improved windows
- Recommissioning / retro-commissioning
- Deadband range expansion

Private Costs and Benefits Estimation - Achievable Potential

Assumptions

Technologies

- Smart Thermostats/Building Automation
- LED Lighting
- Insulation
- Water Heaters
- Heat Pumps
- Windows (Residential)
- Recommissioning

Cumulative retrofit rate by 2030

Technology	ST	LED	INS	WH	HP
Residential	20%	20%	20%	20%	20%
Technology	**BA**	**LED**	**RECOM**	**INS**	**HP**
Commercial	20%	20%	20%	0%	0%

Financial

- Discount rate = 12%
- Values are based on current estimated installed costs for retrofitting, with a learning rate of 3% between now and 2030 and constant relative savings over the lifespan of each technology using an energy price of $0.08/kWh for commercial and $0.10/kWh for residential.
- Difference in maintenance and other costs are negligible
- Administrative costs were excluded

Results

NPV Private Costs	NPV Private Benefits
$2.5B – $5.4B initial costs	$2.0B – $8.0B avoided energy costs

Current State of Retrofitting in Georgia

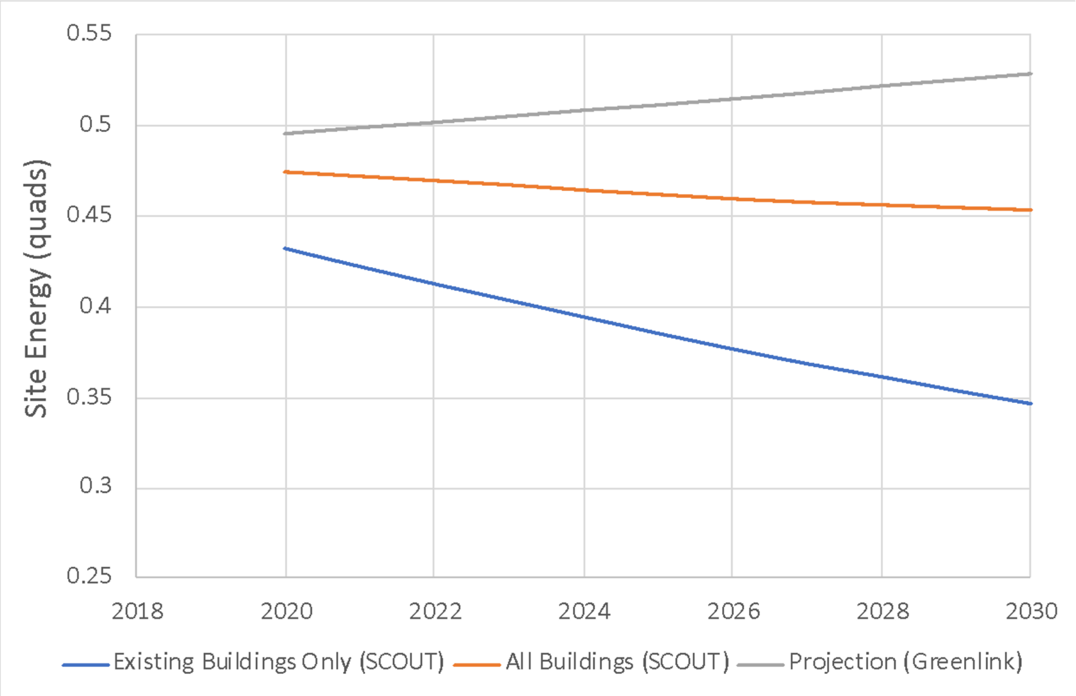
No state-wide program. Georgia Power offers:

- Incentives for single family homes for energy saving solutions ($50 - $300 up to a combined maximum of $1,000)
- Rebates on residential LED lighting and other energy savings options.
- Incentives for commercial buildings for energy saving solutions (up to $75,000/building/year).

Georgia Environmental Finance Authority offers:

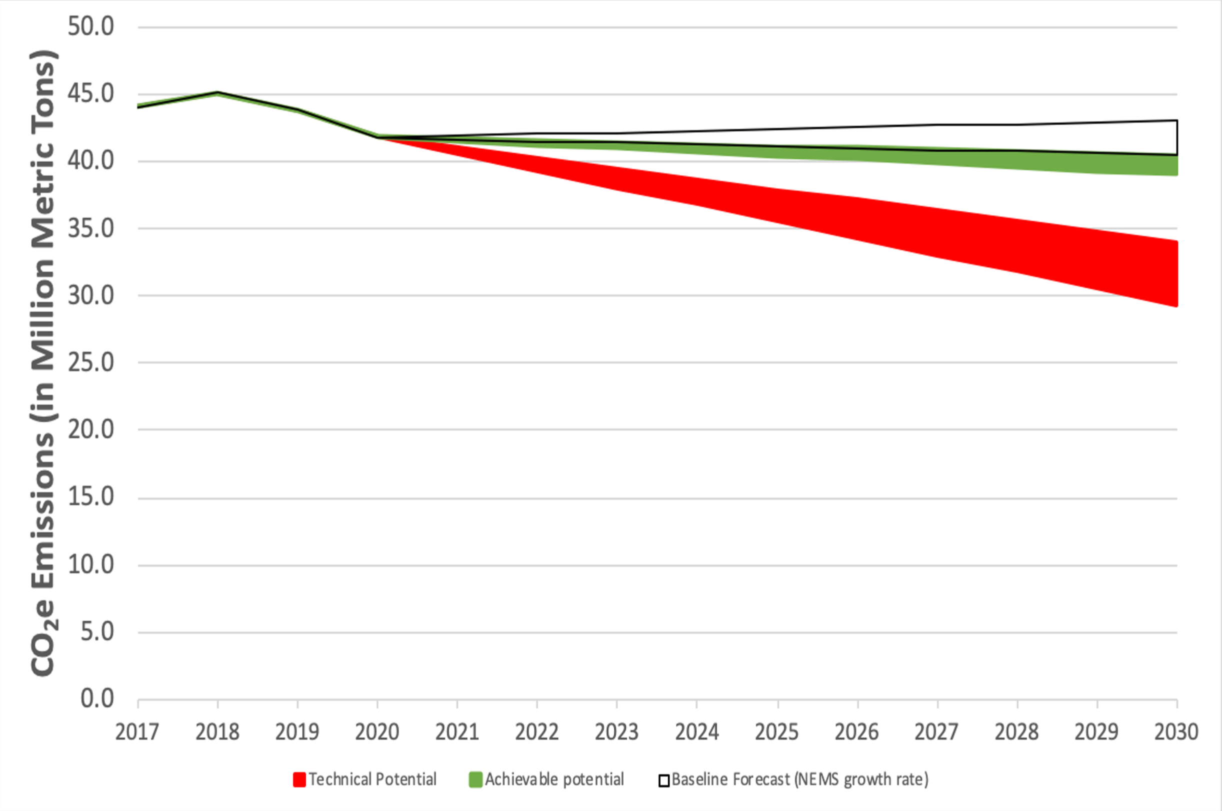
- Low-interest financing for energy efficiency and renewable energy projects for local governments at water, sewer, and solid waste facilities.

Georgia Baseline – Delivered Energy (quads)



Nationwide demolish rate is about 2%. GA residential is closer to 1% and commercial is closer to 3%

Drawdown Potential in Georgia in 2030



Baseline = From 44.1 MtCO_2e in 2017 for commercial and residential buildings, GT-NEMS growth rate forecasts ~43 MtCO_2e in GA in 2030.

Achievable Potential = Reduction of **2.6-4 MtCO_2e** in 2030, considering a cumulative retrofit rate of 20% for deep residential retrofits and for the cost-effective commercial retrofit solutions by 2030.

Technical Potential = Reduction of **9-13.7 MtCO_2e** in 2030, with a cumulative retrofit rate of 50% for all retrofit solutions by 2030.

1 MtCO_2e solution in 2030 = retrofitting around 20% of Georgia's single-family residential homes (approximately 600,000 homes) to achieve an average energy savings of 20% per home by 2030.

+ Less air pollution
+ Local jobs
+ Less energy burden
+ Public health benefits
- High upfront cost

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Beyond Carbon Impacts

Michael Oxman
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Beyond Carbon Working Group

A 6th working group to consider other societal impacts

HEALTH | EQUITY | JOBS | ENVIRONMENT

Objectives:

1. Add/integrate an additional lens to carbon-related technology solution assessments by incorporating *beyond-carbon* impacts

2. Identify cross-cutting beyond-carbon themes for enhancing impact of carbon mitigation solutions

1. Consult with beyond-carbon experts and key stakeholders in order to promote engagement with the Georgia Drawdown Project

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Partnership for Southern Equity — TOGETHER WE PROSPER
Southface
greenlink

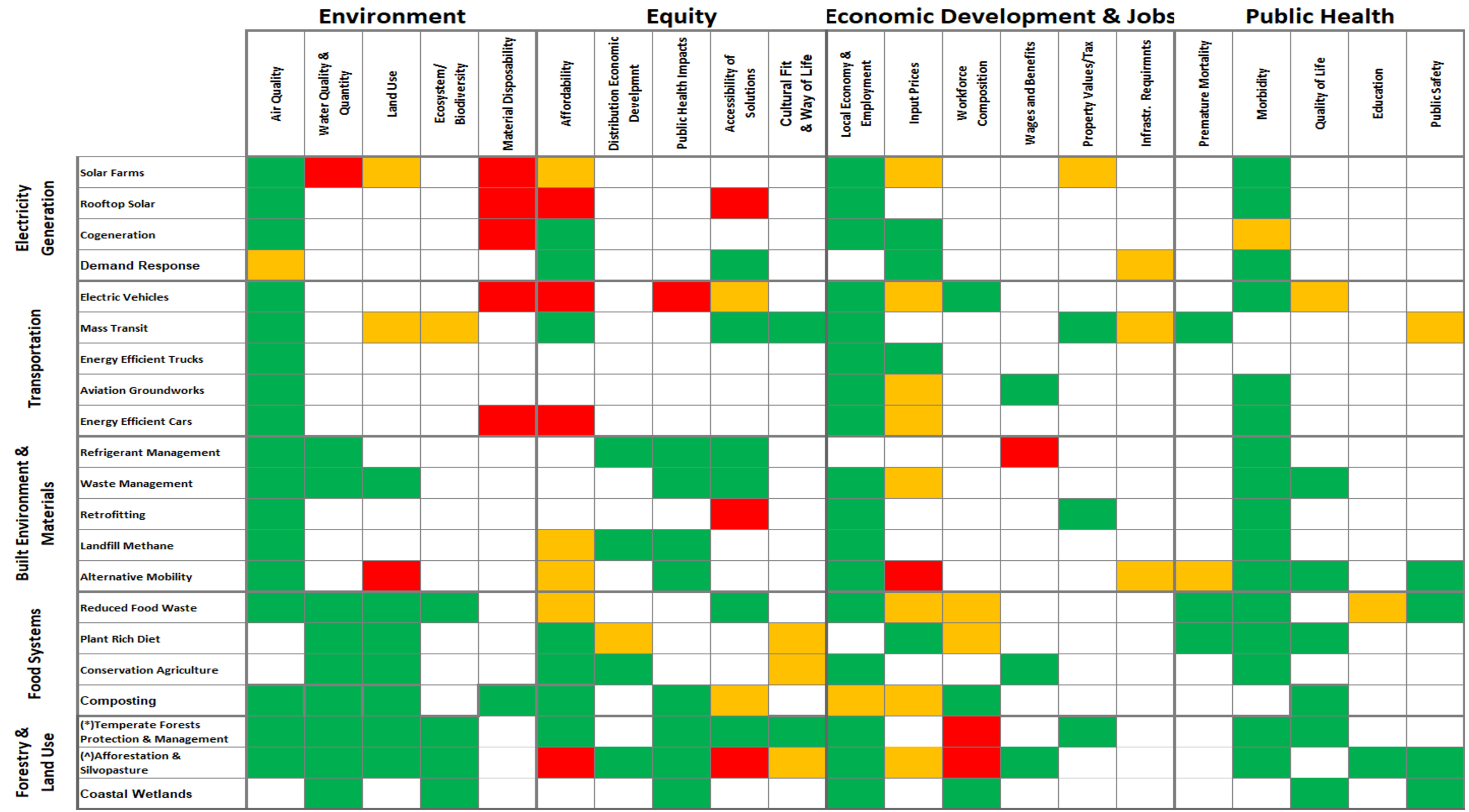
Initial Beyond Carbon Assessments

A Range of Intersecting Attributes Considered

- Environment
  - Air quality
  - Water quality, quantity, and access
  - Land use
  - Ecosystems/ biodiversity
  - Material disposability
- Equity
  - Affordability
  - Diversity of Economic Development & Jobs
  - Distribution of Public Health Impacts
  - Accessibility of Solutions
  - Cultural Fit & Way of Life
- Economic Development
  - Local Economy & Employment
  - Input Prices
  - Workforce composition
  - Wages and benefits
  - Property values / Tax Base
  - Infrastructure requirements
- Public Health
  - Premature Mortality
  - Morbidity
  - Quality of Life
  - Education
  - Public Safety

Initial Assessments Across Multiple Solutions

Material Benefits/Concerns Flagged



21 Solution Summaries

Beyond Carbon Narrative Describes Impacts and Some Promising Approaches

Example: Rooftop Solar

Benefits and Impacts to Manage

- Air quality improvements
- End of life panel disposability
- Installation & maintenance jobs
- Diversity in workforce
- Property values
- Accessibility of solution
- Impact on energy burdens

Promising Approaches

- SEIA/other recycling initiatives
- PSE "just energy" circles
- Targeted entrepreneurial grants
- Community solar programs/net metering
- Low income financing (on-bill, pays, etc.)

21 Solution Summaries

Beyond Carbon Narrative Describes Impacts and Some Promising Approaches

Example: Demand Response

Benefits and Impacts to Manage		Promising Approaches
Air quality improvements		
Resilience	→	Awareness of demand response potential
Customer Savings		Rate design options
Accessibility and/or "penalties" for customers without targeted appliances or less flexible schedules	→	Easing cost barriers for smart grid technologies & tailored offerings for homes with less flexible loads or schedules

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